GUIDELINES FOR
ENVIRONMENTAL ASSESSMENT AND MANAGEMENT STRATEGY
WRECK COVE HYDROELECTRIC PROJECT

Prepared for:
THE FEDERAL/PROVINCIAL TECHNICAL COMMITTEE
BY THE TECHNICAL SUB-COMMITTEE -- WITH
REPRESENTATION FROM:
NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT
PARKS CANADA

CANADA - FISHERIES AND MARINE SERVICE
ENVIRONMENTAL PROTECTION SERVICE
ATMOSPHERIC ENVIRONMENT SERVICE
ENVIRONMENTAL MANAGEMENT SERVICE

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ABSTRACT

A brief description of the project identifies 8 drainage basins on the East Coast and immediate hinterland of Cape Breton Island, which will provide the water supply for the planned production capacity at the Wreck Cove power station of 200 M.W.

The most northerly drainage basin surrounds Cheticamp Lake and abuts on Cape Breton Highlands National Park. The effects of construction and operation in this area are identified as likely to be most critical because of the probable cumulative effects on the immediate pristine environment and the downstream components of the project. Reference is made to the findings of the MacLaren report which identified many environmental concerns. These are reiterated herein and supplemented to form the basis of requirements for a full environmental assessment study. Priorities are established.

Requirements for such an assessment include:

1. A detailed description of all elements of the project.
2. A detailed description and interpretation of the Environmental data base.
3. An ecological description of the area
4. Critical studies, mainly on physical regimes affecting the water quality and therefore the fish habitat. Institutional studies aimed at developing the management plan for the area are also included.
5. An Environmental Impact Assessment to include
   a. an evaluation of the environmental effects of the proposal
   b. the formulation of alternatives in the light of adverse effects
   c. the evaluation of the environmental effects under each alternative, and

d. the evaluation of the acceptability of the project or elements thereof in terms of environmental/economic cost under the best alternative.

6. Management Strategy Formulation, and
7. The identification of environmental monitoring requirements.

Guidelines are provided presenting suitable methodologies to be followed to achieve optimum results.

EXECUTIVE SUMMARY
WRECK COVE HYDROELECTRIC PROJECT
ENVIRONMENTAL ASSESSMENT AND MANAGEMENT STRATEGY GUIDELINES

This summarizes the Guidelines for Environmental Assessment and Management Strategy prepared by the Technical Sub-Committee for Wreck Cove. It highlights the procedures necessary for the conduct of environmental assessment of the hydroelectric development. Specific studies are outlined which are of priority both to the successful completion of a meaningful environmental assessment and to the subsequent reaching of environmentally sound and economically realistic decisions concerning project design, construction, and operational alternatives. Mechanisms by which to reach these decisions are recommended. In addition considerations in formulating management strategy for the area are offered.

Subsequent to the release of the preliminary assessment report prepared by MacLaren Atlantic Limited for the Nova Scotia Power Corporation, a multitude of concerns were expressed. These concerns dealt with the effects of the proposed project on the environment and were voiced by government agencies, environmental groups, private citizens, and the media. Following a review of these concerns, the Technical Sub-Committee has defined the range of those matters which require immediate attention and developed guidelines for the conduct of studies relevant to these concerns.

The guidelines produced resemble the terms of reference developed for the MacLaren Atlantic Study. However, it is recognized that the MacLaren Atlantic Study was a preliminary environmental impact study with the purpose of identifying major areas of concern and recommending additional studies. Many recommendations made in that study were valid and in fulfillment of the original

objective, however, budgetary and time constraints as well as data limitations were not conductive to a thorough evaluation and identification of the major areas of concern. One of the major departures from the MacLaren Atlantic Study in the guidelines prepared by the Technical Sub-Committee is the emphasis on the completion of a comprehensive evaluation of economic/environmental costs to be considered in all steps of the Wreck Cove development.

The determination of environmental impact is categorized by a number of successive and interdependent stages. These are (1) collection of data base, (2) primary interpretation of data base, (3) conduct of specialized studies to supplement data base, (4) overlay of project, (5) assessment of project impact, (6) suggestion of alternatives, (7) assessment of impact of alternatives, and finally (8) the determination of the acceptability of the project. Steps (6) and (7) in this process are connected ideally into a feedback loop such that initially unacceptable design may be supplemented by alternative design, evaluated and modified further if necessary prior to implementation

The studies outlined below and presented in more detail in the full guidelines can only be useful to the design of an environmentally compatible hydroelectric development if the feedback mechanism referred to above is put in place. This may be accomplished by way of a form of joint committee comprised of the Nova Scotia Department of the Environment (N.S.D.O.E.), Nova Scotia Power Corporation (N.S.P.C.), Parks Canada and Environment Canada. Since the initial stages of the development are proceeding, the studies contributing to the environmental assessment will not be used to assess "(8)" above, namely, the acceptability of the project in total, but will be used to assess the acceptability of individual phases of the project through the successive assessment of alternatives outlined above for steps (6) and (7). However, timing of decisions affecting the hydro pro

2. DOWNSTREAM EFFECTS

Another principle area of concern which has received limited attention in the MacLaren report relates to the effect of the proposed project on the downstream reaches of the diverted rivers. Studies should be initiated to assess the natural resources of the downstream reaches of each of the diverted streams and to evaluate the environmental impacts of changes in the hydrologic and water quality regimes resulting from the proposed project. The "natural" resources referred to above include fisheries, wildlife, recreation, water supply and any other such uses that the water resources are or may be put to. This assessment will include an evaluation of alternative riparian flow releases and will consider the water quality of such releases. Various environmental designs including but not limited to multiple intake dams and siltation or settling basins will be considered. Another major consideration will be the impact of alterations in the hydrologic/ geomorphological regime on the stream bed characteristics such as potential loss of gravel spawning beds for fisheries.

3. OTHER SPECIFIC ENVIRONMENTAL IMPACTS

Studies should be undertaken to estimate the depths from which water of the most favourable temperature should be drawn for maintenance flows. These depths will depend on the vertical temperature profiles of the reservoirs. Therefore, simulation of the temperature regimes in Wreck Cove, Gisborne, Cheticamp and McMillan Reservoirs should be carried out. Vertical temperature profiles should be predicted for each month. The simulations should take account of the expected operating strategy of the proposed reservoirs and the effects which the outlet levels for maintenance flows and for power generation will have on the temperature profiles. Field data used in these simulations should be collected at the appropriate sites at Wreck Cove. If necessary, consideration should be given to the provision of several alternate outlets at different levels.

The preliminary assessment carried out by MacLaren Atlantic

Limited indicates that severe depletion of dissolved oxygen may occur in the proposed reservoirs. If this is the case, the streams will be deficient in oxygen for some distance below each dam. Studies should be undertaken to provide a more accurate quantitative prediction of the extent of oxygen depletion likely to occur in the impoundments, and to what extent this situation is likely to change with impoundment ageing; taking into account the expected operating strategy for power generation, and discharge of water (possible from more than one depth) for stream maintenance flows. Studies should be undertaken to predict if possible the amount of suspended material in the water released downstream and where it will eventually be deposited. The studies should consider the hydrologic regime of each reservoir as well as estimates of wave energies, erosive effects of ice and groundwater flows. Effects of shoreline slopes, vegetation and of soil characteristics on suspended sediment regimes should be estimated. Soil samples should be collected from the future reservoir shorelines and particle size and settling rate determined.

The Cheticamp reservoir is unique in that a raised sphagnum bog would be flooded. The decay of submerged terrestrial and bog vegetation of this type under anaerobic conditions, as may prevail in the Cheticamp Reservoir, may produce toxic substances quite harmful to the fishery and other water uses. Studies, of the effects of the decomposition of peat must be carried out as a prereguisite to the environmental impact assessment of the Cheticamp component.

4. MANAGEMENT STRATEGIES

The basic premise employed throughout these guidelines is that any decisions that affect more than one resource base or use must reflect or be based on a comprehensive evaluation of all

costs involved. It is hoped that any major decision respecting the proposed power development or components there of be based on a framework of multiple resource management. It must be recognized that it is not possible in all cases to establish a dollar figure on a natural resource such as fisheries. However, it is possible to compare the costs/benefits in subjective terms.

Each major alternative or combination thereof must be evaluated from the perspective of additional cost of loss of capacity/energy to the project. This will establish the cost to the project in dollars. Painted against this background, the relative "environmental" benefits/losses, whether they be tangible or intangible must be formulated. When evaluating environmental benefits/losses, it is suggested that consideration be given to opportunity losses but that the basis for comparison be existing conditions.

In determining the management strategy, the following should be considered:

1. The provision of the area or parts of it to the general public as a recreation area required the following considerations:
   a. An examination of N.S.F.I.* policy re access roads and the compatible formulation of a joint policy governing access to all roads including those of the N.S.P.C. This has a number of implications, the most notable of which is the requirement to provide an accessible road and to maintain it.
   b. If an "open door" policy is adopted for an area, the environmental effects, notably aesthetics, will become more severe if an accessible reservoir is subject to excessive fluctuations.

* N.S.F.I. - Nova Scotia Forest Industries

c. An "open door" policy will be enhanced if management options such as fish stocking, provision of recreation facilities, etc., are provided.

2. Incompatible resource use objectives such as the concept of a wilderness area, a policy of Parks Canada, and the "open door" policy of N.S.F.I., require rationalization.

3. The multiplicity of use has to be resolved as to whether uses overlap or abut over the area. Zoning for uses may be required.

The management of a resource requires an up-to-date knowledge of the state of the entity being managed. This is normally accomplished through a network of stations at which various indicator parameters are monitored on a regular basis. A comprehensive network of environmental monitoring sites encompassing the factors listed below must be designed and established. The design must be based on the management strategy adopted.

a. hydrometric network
b. climatological network
c. water quality
d. fishery resource
e. wildlife resource
f. forestry
g. recreational activity

Nothing in this statement of the requirements for environmental impact assessment negates the responsibility of N.S.P.C. and their agents to abide by all existing legislation and regulations imposed by agencies of all levels of government having jurisdiction in the areas under consideration.

1. Introduction

Subsequent to the release of the preliminary assessment report prepared by MacLaren Atlantic Limited for the N.S.P.C., a multitude of concerns regarding the effects of the proposed project on the environment have been voiced by government agencies, environmental and resource groups, private citizens, the media, etc. Based on a review of these concerns and an evaluation of all pertinent data, the Committee has narrowed down the range of concerns which require immediate attention.

This report deals with those aspects of the proposed project which require detailed assessment or special studies. Those aspects requiring detailed environmental assessment include; the Cheticamp River basin, the downstream reaches of each of the diverted streams and a variety of other environmental concerns ranging from the resulting water quality regime in each of the proposed reservoirs to erosion/siltation resulting from construction activities.

Related to the environmental impact assessment and key to the long term effects of the proposed project are the management strategies and operational policies adopted for the project and its immediate area. The management strategies must be formulated within the framework of multiple-resource management. This would include but is not limited to forestry, wildlife, fisheries and recreation. As such it would be best formulated by various agencies of the Nova Scotia government, Environment Canada and Parks Canada.

The guidelines as contained herein resemble to some degree the terms of reference developed for the MacLaren study. However, it must be recognized that the MacLaren study was a preliminary environmental impact study which would serve to identify major areas of concern and to recommend additional studies of those aspects of the proposed project which were identified as having a significant adverse effect on the environment. Many of the MacLaren recommendations made in

study were valid and in fulfillment of this basic objective. It must be reiterated however that time, budgetary and information constraints imposed on the consultant were not conducive to a thorough evaluation of the major areas of concern. These guidelines depart from the terms of reference of the MacLaren report in that a complete and comprehensive evaluation of the economic/environmental costs is required.

Nothing in this statement of the requirements for environmental impact assessment negates the responsibility of N.S.P.C. and their agents to abide by all existing legislation and regulations imposed by agencies of all levels of government having jurisdiction in the areas under consideration.

2. PROJECT DESCRIPTION

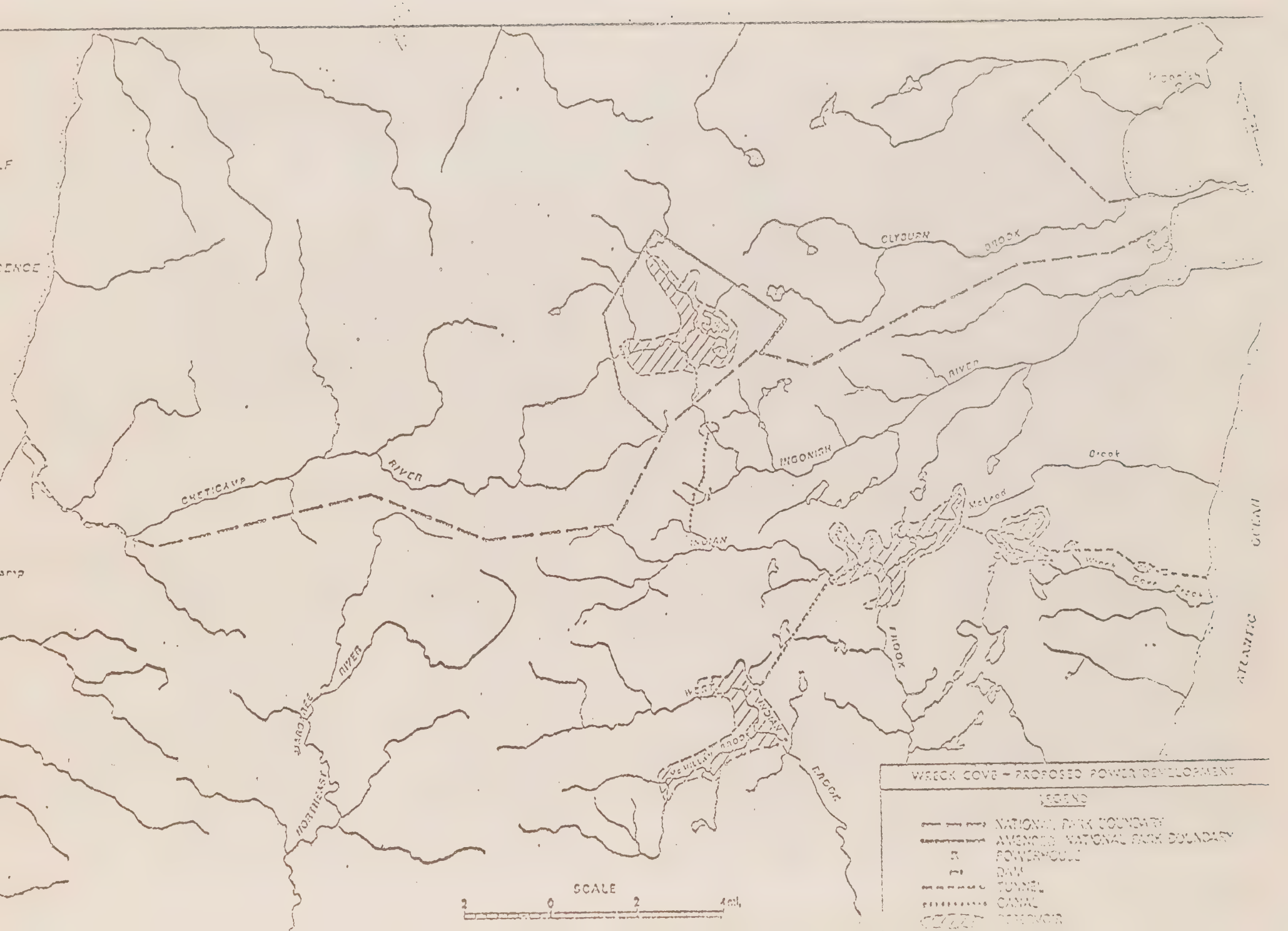
2.1 The Power Development

The Wreck Cove hydroelectric project is located on the east coast of Cape Breton Island, northwest of Sydney, in the Province of Nova Scotia. The development area falls mainly within the county of Victoria and borders on the Cape Breton Highland National Park. The northern portion of the project includes a parcel of land surrounding Cheticamp Lake that was removed from the Park by an ammendment to the National Parks Act in 1958. A location map illustrating the principal areas of the project is shown on Figure I.

The installed capacity of the power plant is 200 M.W., designed for peaking operation at an annual capacity factor of 15%. Generally the plant will be operated 4 to 5 hours per day, five days a week with minimal weekend use. Short term base load capacity of the plant for emergency requirements will be limited to 100 M.W. The project is scheduled to be on stream in 1977.

To provide sufficient flow and storage capacity for power generation the flow in six drainage basins on the highland plateau will be diverted to a forebay located at Surge Lake. The following is a list of diverted drainage basins required together with the area of each.

Basin	River or Brook	Drainage Area sq. mi.
Cheticamp Lake (Diversion)	Cheticamp	19.0
Ingonish (Diversion)	Ingonish	3.24
Ingonish (Diversion)	Ingonish	2.03
Gisborne Lake (Diversion)	Indian Brook	20.63
McLeod Brook (Diversion)	McLeod Brook	0.95


CLYDUAN BROOK
RIVER
INGONISH
Brook
McLeod
CHETICAMP
RIVER
INDIAN
Wreck Cove Brook
FRENCH
ATLANTIC OCEAN
MARGAREE
RIVER
NORTHEAST
WRECK COVE - PROPOSED POWER DEVELOPMENT
LEGEND
NATIONAL PARK BOUNDARY
AMENDED NATIONAL PARK BOUNDARY
POWERHOUSE
DAM
TUNNEL
CANAL
RESERVOIR
SCALE
2 0 2 4 mi.

Basin	River or Brook	Drainage sq. mi.
McMillan Brook (Diversion)	West Indian Brook	31.66
Wreck Cove Lake (Diversion)	Wreck Cove Brook	6.65
Surge Lake (Forebay)		0.?
	Total	84.12

Eleven earth and rockfill dams will be constructed in the above drainage basins to provide reservoir storage. Diversions between reservoirs will consist of six canals totalling 20,600 feet and two tunnels of 15,950 and 12,000 feet respectively.

From the Surge Lake forebay at a mean elevation of 1181 feet, the water enters a 1600 foot long penstock tunnel leading to two turbines at elevation 1.0 feet located in an underground powerhouse. Two 100MW generators operated from a surface control building on the north bank of Wreck Cove Brook will provide the energy output of the project. The tailrace discharge will flow directly into the Atlantic Ocean through a 5300 foot long tunnel approximately one and one-half miles north of Wreck Cove Brook.

2.2 Project Roads

Approximately 30.55 miles of new road will be required to provide access to structure sites and borrow areas. In addition, the existing road from the Cabot Trail to the access tunnel and plateau must be upgraded. This represents approximately 11 miles of improvement. Another access road up the Wreck Cove Brook Valley is now part of the overall project.

Project construction roads have been estimated based on a 24 foot top with a one-foot thickness of subgrade material and 6 inches of gravel surface.

An investigation is underway on the use of water permeable non-woven synthetic fiber membranes to act as a separation filter and reinforcement agent between the natural or stripped surface and the subgrade material. Testing of the fiber will be carried out primarily in wet ground and boggy areas. Should testing of the fiber indicate substantial savings in full requirements and construction cost, its use may be incorporated in the design specifications for roads.

Following project completion, some additional road construction will be required to upgrade construction roads into a permanent plateau road system. This may require some diversion work to reroute temporary roads over some of the completed dams or access canals.

Construction of project roads will be a critical activity in terms of access to major project structures and borrow areas in the McMillan and Cheticamp Basins.

2.3 Transmission Lines

Routing of transmission lines has not been finalized. The plans include a corridor of about 200 feet wide from the power station at Wreck Cove southward about 18.5 miles to the end of the existing corridor at Tarbot.

2.4 Campsites

In addition to the campsite at the Cabot Trail, a base camp housing 400 to 500 people is planned for the plateau area in the vicinity of dam D-4.* Helicopter support will be required for the reconnaissance and survey parties operating out of this camp, as well as for manpower mobilization.

* See Figure 3 - Page 20a

3. APPROACH TO ENVIRONMENTAL ASSESSMENT

3.1 General

The determination of environmental impact is categorized by a number of successive and interdependent stages. These are: (1) collection of data base, (2) primary interpretation of data base, (3) conduct of specialized studies to supplement data base, (4) overlay of project, (5) assessment of project impact, (6) suggestion of alternatives, and (7) assessment of impact of alternatives, and finally (8) the determination of the acceptability of the project. Steps (6) and (7) in this process are connected ideally into a feedback loop such that initially unacceptable design may be supplemented by alternative design, evaluated and modified further if necessary prior to implementation.

The studies outlined below and presented in more detail in the full guidelines can only be useful to the design of an environmentally compatible hydroelectric development if the feedback mechanism referred to above is put in place. This may be accomplished by way of a form of joint committee comprised of N.S.D.O.E., N.S.P.C., Parks Canada and Environment Canada. Because the Wreck Cove Development is to proceed, the studies contributing to the environmental assessment will not be used to assess "(8)" above, namely, the acceptability of the project in total, but will be used to assess the acceptability of individual phases of the project through the successive assessment of alternatives outlined above for steps (6) and (7). However, timing of decisions affecting the hydro project is critical. A number of decisions affecting the details of design, construction, and operation will have to be made during the accumulation of the additional data outlined below. Some decisions can probably be deferred until the data base has been expanded sufficiently to allow meaningful assessment of alternatives.

Furthermore, the environmental inventory to be gathered and interpreted will require comprehensive documentation re sources of information, methods utilized, and the identification of problems, with reasons, in acquiring information. Also, the final decision of the acceptability of the project as a whole or parts thereof must be supported by appropriate literature, or personal citations.

As a further note, it must be pointed out that much of the data base already exists in one form or another. The requirement of these guidelines in this regard is to compile these data into a form suitable for environmental impact assessment and to provide a comprehensive interpretation.

3.2 Environmental Concerns

These guidelines address themselves to a variety of environmental concerns expressed by various governmental agencies, public and private groups concerned with environmental protection and conservation, private citizens, the media, and by members of the Technical Committee. The approach adopted herein has been to group these concerns into four principal areas. The following listing of concerns is by no means exhaustive and is meant only to encapsulate those major areas which require detailed assessment. Throughout the process of the environmental assessment activities, a number of concerns may be deleted from and/or added to this list.

A. CHETICAMP RIVER BASIN

The Cheticamp impoundment/diversion component of the project has been identified as potentially the most environmentally sensitive area of the project for the following reasons:

(i) Alteration in the hydrologic and water quality regimes may affect the fishery resources of the

Cheticamp River notably Atlantic Salmon. Other water resources uses may also be affected.

(ii) Flooding of the Cheticamp bog complex may obliterate unique species of flora. In addition, valuable habitat for fauna will be eliminated.

(iii) The proposed impoundment and construction activities may affect migratory routes for fauna in the area.

(iv) Construction activities may introduce large volumes of sediment into the Cheticamp River affecting downstream water resources including the estuarial resources.

B. DOWNSTREAM EFFECTS

Alterations in the hydrologic, geomorphological and water quality regimes of the downstream portions of each of the diverted streams will affect the fishery resources and may affect other water resources uses.

C. OTHER ENVIRONMENTAL IMPACTS

Because of the impending construction activities for those components of the project other than the Cheticamp, it was decided that major changes in their design could not be implemented and as such a detailed assessment would be to no avail. Rather, it was decided that specific activities such as dams, access roads, borrow/disposal areas, transmission line routing, camp sites, etc. should be assessed with a view towards

(i) minimizing erosion/siltation of streams

(ii) minimizing the disruption of unique species of fauna and flora

(iii) minimizing disruption in habitat and migration routes for fauna

(iv) maximizing the aesthetics of the area for the areas accessible (both present and future) by the general public.

D. MANAGEMENT PLAN

The development and implementation of a detailed multiple resource use management plan is the key to the long term environmental impact of the project.

4. DETAILED IDENTIFICATION OF THE PRINCIPAL FEATURES OF THE PROJECT

4.1 General

The main features of the project including the dams, impoundments, canals, borrow areas, dump sites (including spoil from canals) access roads (both temporary and permanent), transmission lines, tunnels, control and reception buildings and camp sites should be mapped and described in detail as follows.

The principal features referred to above should be mapped, wherever possible, at the same scale as the biophysical baseline data to allow the identification of potential environmental effects on such factors as wildlife habitat, wildlife migration, vegetation, drainage, erosion and sedimentation, aesthetics, etc.

In addition to the above, each feature should be described along the following guidelines supported by appropriate drawings and cross sections.

A. DAMS

- type of construction and materials used
- timing of construction
- description of spillway including design level and design flood
- description of outlet structures including depth below spillway, approach and exit velocities, head, etc.
- description of intended operating policy and procedures
- description of any environmental design features that are contemplated
- describe dump/spoil areas proposed

B. CANAL

- describe physical characteristics including length, cross section, slope (along axis) etc.
- describe nature of excavation in terms of rock/soil type
- describe method of excavation and intended disposal area
- describe typical cross sections in terms of side slopes, bank protection, etc.
- describe velocities (range) that are contemplated including approach and exit velocities
- describe design flow
- describe operation and maintenance policy
- describe environmental design features contemplated

C. IMPOUNDMENT AREAS

- describe watershed in terms of physical characteristics such as area, slope, dominant vegetation types, surficial geology, stream lengths, etc.
- provide storage volume (live and dead)
- provide minimum and maximum reservoir area
- provide minimum and maximum reservoir depths
- provide hydrographic chart of reservoir (10' contours)
- describe the intended operational policy to be adopted for the reservoir and provide water level and flow hydrographs over a 50 year period
- describe any environmental design considerations being contemplated including reservoir clearing and slash considerations

D. ACCESS ROADS

- describe the road construction methods to be utilized in crossing both non-organic and organic terrain
- identify the form of drainage bypass mechanisms utilized and their locations
- identify sources, quantity and type of material utilized for road construction

- identify spoil disposal sites and where such operations are to be carried out
- identify the policy of maintenance of these roads re length of time expected to be used.

E. TRANSMISSION LINES

- describe road construction methods and material source
- identify drainage mechanism utilized and locations
- identify vegetation control methods, schedules and materials
- identify width of right of way and where service road will depart from it

F. TUNNEL

- identify material to be excavated in terms of toxicity and sediment content
- describe dumping sites
- describe excavation methods and by products (waste water, rock powder)

G. CONTROL AND RECEPTION BUILDING

- identify projected use of the facilities
- identify sewage treatment facilities

H. CAMP SITES

- identify location
- identify capacity and layout
- identify sewage treatment facilities
- identify solid waste disposal practices
- identify water sources
- describe any long term use of each site if any

5. ENVIRONMENTAL INVENTORY

The compilation and interpretation of environmental baseline data effecting or affected by the project is a key element in the determination of environmental impact and in the formulation of subsequent management plans. In some instances, these data are available from other studies conducted for/by the N.S.P.C. However, they have not been compiled in a form suitable for detailed assessment. Unless otherwise noted, the mode of data presentation shall, wherever possible, be a map with a scale of 1:15, 840 (scale of current L & F photography) supported by appropriate written description. In other instances, a written description supported by appropriate tabular results is required. Unless otherwise noted, the scope of the biophysical elements includes those portions of the project area affected by construction/operation activities.

5.1 Baseline Data

A. PHYSICAL TERRAIN

1. Landform (utilize the landtype format)[1]
   - origin of material (till, alluvium, etc.)
   - depth of material
   - texture (grain size distribution per land type)
   - moisture regime
   - topography based on ten foot contours

NOTE: For the Cheticamp impoundment, the above information should be mapped at a scale of 1" = 400 feet with a contour interval of 10 feet. The entire reservoir plus 100 feet (horizontal) around the fringe should be included.

2. Soil (Canadian soil classification system)

1. "Guidelines for a Biophysical Land Classification" compiled by D. Lacate 1969 Dept. Fisheries and Forestry Pub. No. 1264

3. Geology (bedrock)
   - hydrogeology
   - new data from seismic activity, drilling

4. Microdrainage

B. PLANT COMMUNITIES (Within land type boundaries)
1. Tree, shrub, herb, ground cover, aquatic species
2. Abundance/dominance
3. Sociability
4. Succession

C. CLIMATE (for the whole project area - Scale 1:50,000)
1. Wind roses (summer, winter, annual)
2. Monthly temperatures (mean, mean maximum, mean minimum)
3. Seasonal snowfall (mean and variance)
4. Monthly and annual total precipitation (mean and variance)
5. Snow depth (monthly)
6. Snowpack mapping (water equivalent) (monthly)
7. Evaporation (monthly)
8. Evapotranspiration (monthly)
9. Water surplus (monthly)
10. Frost data and frost free period (median and extreme)

NOTE: Climatological studies to be based on data collected in the 1941-1970 standard wherever possible, supplamented by short term or subsequent data if necessary.

D. WATER QUALITY
1. A downstream monitoring program incorporating the following parameters shall be initiated; temperature, pH, dissolved O_2, suspended and dissolved solids and any such parameters that may impact on water use as identified in 5.1 E and/or 5.2 F. Location of above stations should be established under the advice of N.S.D.O.E., Environment Canada - Fisheries and Marine Service, and consent of N.P.S.

2. The reservoir sampling as established by N.S.D.O.E. early in 1975 is to be continued until such time as the final regime is established.

E. LAND/WATER USE

1. Forestry

Existing and projected forest management plans for the area should be mapped at a scale of 1:50,000.

2. Recreation

The patterns and levels of recreational activity in the area, with particular emphasis on the downstream portions of the diverted streams, should be presented. The type and location of all recreational facilities should be mapped.

3. Water Use

Any form of water use such as domestic-commercial-industrial that may be affected by the project should be quantified noting appropriate water quality requirements. This will include groundwater sources where same may be affected by reduced flows.

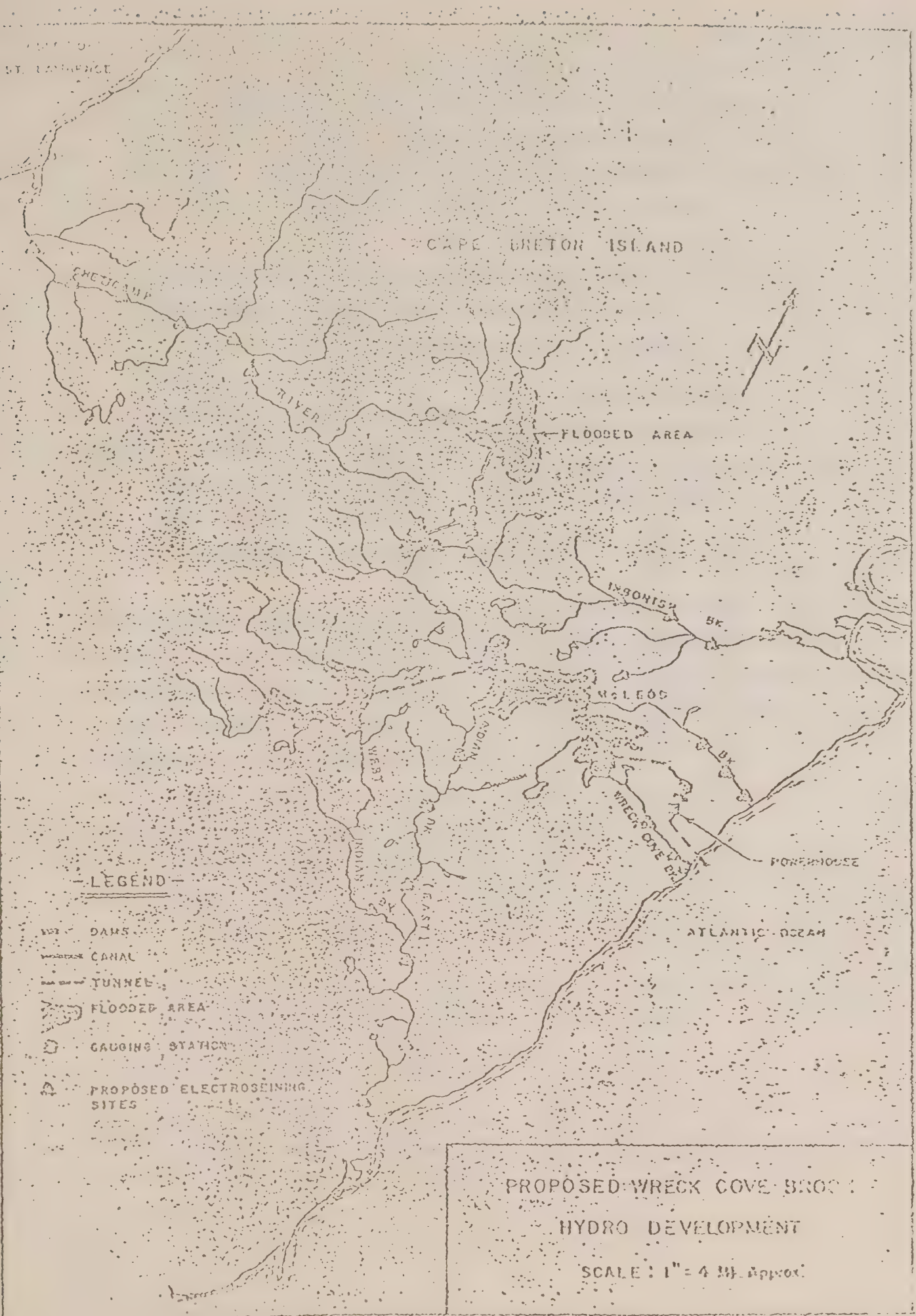
4. Land Use

Existing and planned land use characteristics in the downstream reaches of the diverted streams should be presented in map form. This includes the estuarine communities.

F. NEAR SHORE RESOURCES AND ACTIVITIES

1. Oceanographic Study of Estuarial Sediment Distributions

The reduced flows may be insufficient to maintain the channels through the sand and gravel bars at the mouth of each of the diverted rivers, and during periods of low flows or storms the estuaries may become closed.


CAPE BRETON ISLAND
FLOODED AREA
INGONISH BK
MACLEODS
WRECK COVE BK
FORTRESS
ATLANTIC OCEAN
— LEGEND —
DAMS
CANAL
TUNNEL
FLOODED AREA
GAUGING STATION
PROPOSED ELECTROSEINING SITES
PROPOSED WRECK COVE BROOK
HYDRO DEVELOPMENT
SCALE : 1" = 4 Mi. Approx.

required at 1.5 mile intervals until a total obstruction is encountered. It is estimated that this will require four sites on the lower river and an additional three in the proximity of the proposed dam sites, as shown in Figure II.

(d) McLeod Brook

On this brook two sites were completed in 1974. These sites should be redone and one more added above these as shown on Figure II.

(c) Wreck Cove Brook

Three electroseining sites were done in 1974 and these sites should be repeated in 1975. Location of the sites are shown on the Figure II.

II. PHYSICAL HABITAT AND STREAM HYDRAULIC STUDIES

1. Habitat Survey

The locations and amounts of suitable spawning and rearing habitat should be described for all affected streams. Preliminary physical surveys have already been carried out on some affected streams. The information gained in these surveys may be combined with physical data collected at electroseining sites to provide adequate habitat descriptions of Cheticamp River, Wreck Cove and McLeod Brook. However, physical studies of Indian Brook and the lower reaches of Ingonish River will be required in 1975.

(a) Indian Brook

An assessment of the potential rearing capacity of the Indian Brook system must be made in order to evaluate the possibility of providing access for Atlantic salmon to the system. Surveys must be undertaken in conjunction with the profile surveys to provide a complete description of habitat conditions to determine the amount of spawning and rearing area available.

of bed material should be carried out during the survey [illegible] discharge soundings should be carried out to develop a stage-discharge relationship for the river reach surveyed.

It should be realized that any discharge specified for maintenance flow should be related to several hydraulic parameters which are indicators of suitable fish habitat conditions. These factors are wetted perimeter, mean and maximum depth, and average velocity through the cross section. Each of these factors must be plotted against discharge so that a maintenance discharge can be selected based upon a minimum acceptable value (or critical value) for the selected factors.

The reaches that should be surveyed are shown in Figure III. These reaches were selected as being immediately below each of the diversion dams and also several other reaches determined to be suitable by a preliminary study of the 1:50,000 National Topographic Series maps.

I. HYDROLOGY

1. Compilation and statistical analysis of monthly mean stream flows as recorded at the following hydrometric stations - Cheticamp River above Robert Brook, Cheticamp River below Cheticamp Lake, the Northeast Margaree River at Margaree Valley, Indian Brook near Matheson's Lake, Indian Brook at Indian Brook and Wreck Cove Brook near Wreck Cove is required.

2. Streamflow hydrographs for the period of record for each of the above hydrometric stations must be prepared.

The section of East Indian above the Gisborne Lake Reservoir must be examined carefully in relation to the provision of spawning areas for speckled trout from the reservoir. The survey must be designed to determine the suitability of trout spawning and rearing areas with emphasis placed on present bottom materials, pools, water quality and temperatures in addition to the survey requirements listed for the overall system.

(b) Ingonish River

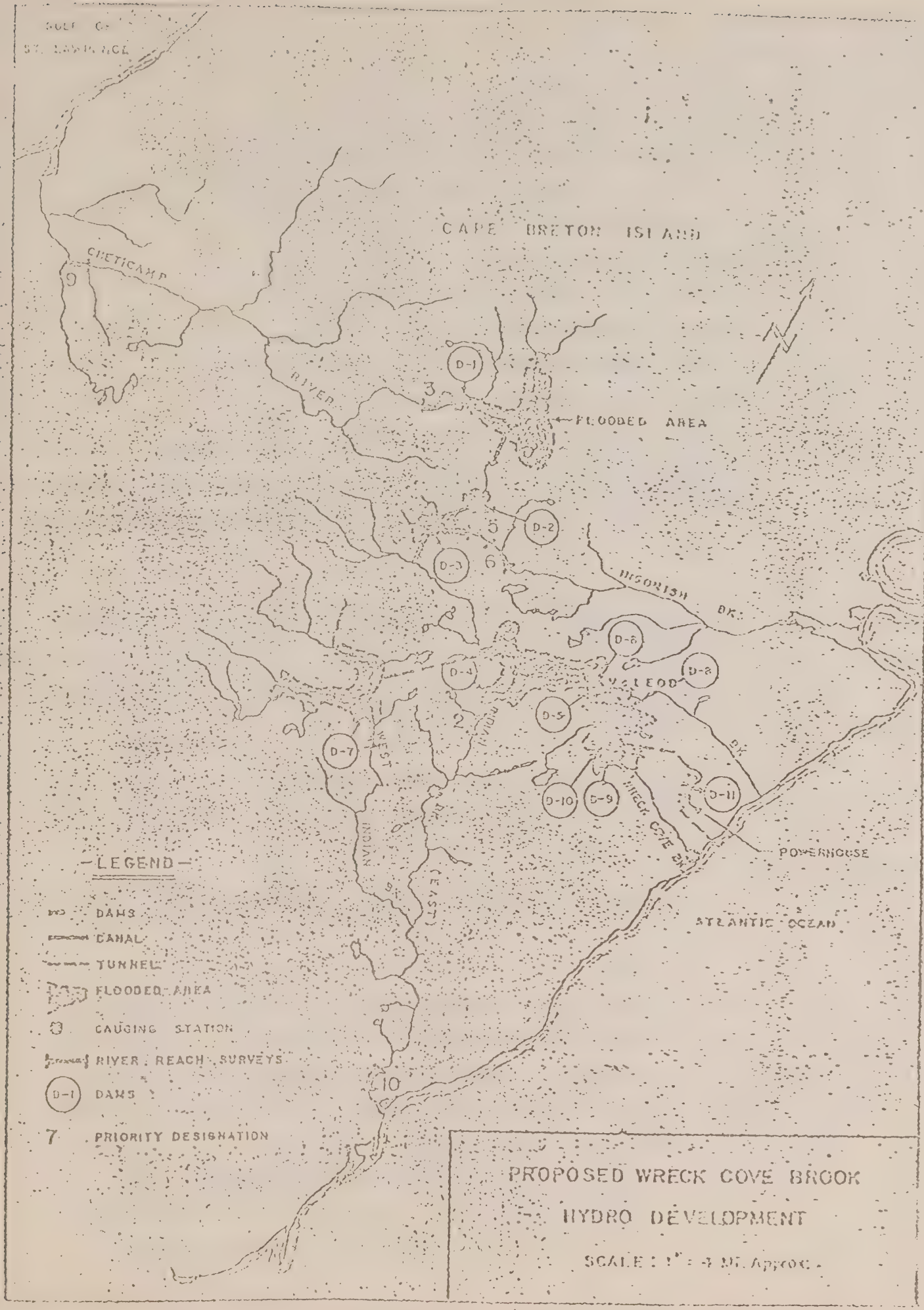
A physical survey of Ingonish River must be made similar to that for Indian Brook. This should extend from the mouth about 4 miles upstream. A general description of the system must be given including the location and height of all obstructions, detailed descriptions of rapids and other problem areas plus all the information required for Indian Brook.

2. Stream Hydraulics

The maintenance flows proposed by the Fisheries and Marine Service[1] were based on a statistical hydrological analysis. This method of estimating flows required to protect fish is less satisfactory than one based on a physical measurements on selected river reaches. In order to relate river flows to maintenance of fish habitat a physical survey should be carried out on each affected stream.

The river survey should be carried out at several stream cross sections to determine cross sectional data up to the bankfull level, water surface elevation and bed profile. Discharge meterings and sampling

1. Wreck Cove Hydroelectric Development Fisheries concerns and Future Study Requirements. Resources Development


CAPE BRETON ISLAND
CHETICAMP
RIVER
FLOODED AREA
D-1
D-2
D-3
D-4
D-5
D-6
D-7
D-8
D-9
D-10
D-11
MACLEOD
BROOK
WRECK COVE BROOK
POWERHOUSE
ATLANTIC OCEAN
WEST
MAIN
EAST
LEGEND
DAMS
CANAL
TUNNEL
FLOODED AREA
GAUGING STATION
RIVER REACH SURVEYS
DAMS
PRIORITY DESIGNATION
PROPOSED WRECK COVE BROOK
HYDRO DEVELOPMENT
SCALE: 1" = 4 MI. Approx.

5.2 Analysis and Interpretation

A. ECOLOGICAL DESCRIPTION OF THE AREA:

1. A habitat map of the area is required to cover:

   (i) big game
   (ii) waterfowl
   (iii) fur bearers
   (iv) upland game
   (v) song birds
   (vi) shorebirds

   The habitats are to be determined by field investigations, aerial photo interpretation and inference from the plant community and physical terrain maps plus the climatic data.

   As the accurate identification of most of these habitats can only be done after a field investigati extending over a minimum of one year, revisions of ratings are to be expected.

2. Under this section, the following must be included in a format suitable to accurately predict and assess alterations by the project.

   (i) Species habitat sites, relationships and behavioural ecology of animals living and dependent in part or in total on the lands under development and circumjacent terrain must be described and presented along with pertinent maps. This information must be sufficient to present an accurate appraisal of pre-construction conditions and alterations imposed by the development. The information will be sufficiently complete to provide definite impact assessments.

(ii) Identification of food chains and other inter-species relationships susceptible to an impact from the hydro development.

(iii) Description of the local ecological succession and the present status.

(iv) Identification of definable pre-existing environmental stresses such as important histories of disease occurring in the regional biota as well as vectors or reservoirs of disease or serious infect-ations by pest species. These baseline data will help assess the long term effect of the project on the area by correctly identifying the cause of disruption.

B. TRAFFICABILITY OR TERRAIN SENSITIVITY

Each of the land types identified in the physical terrain map above (5.1A) must be rated on capability to support traffic. This requirement is in view of the predominant organic terrain in and around the Cheticamp Lake area for example which is highly susceptible to impairment from trafficability. Furthermore, indiscriminate road layout may result in serious disruption of the drainage patterns of the area and hence alter the present pattern of bog, muskeg and tree cover. The rating should be developed by utilizing the microdrainage, landform, plant community and geology maps.

C. POTENTIAL BORROW AREAS

Within each land type (5.1A) identify the capability to sustain any mining of borrow material. Factors that should be reflected in the rating are access, material suitability for specific use, importance of type to environmental concerns, i.e. habitat, key type to system, rarity or uniqueness to area.

D. ERODABILITY OF TERRAIN

Using topography and soil texture (gradation curves) identified under 5.1A fashion an erosion susceptibility rating for each of the land types affected by construction and operation of the proposed project.

E. HYDROLOGIC ANALYSIS

Using monthly mean streamflows as recorded at the various hydrometric stations, construct a hydrologic/water balance model of each of the affected streams. Estimates of precipitation, evaporation and snowpack storage as determined in 5.1C and provision for lake/bog storage form integral input to the models. The objective of each model will be to mirror the existing regime on each stream at various locations as determined by the Fisheries and land/water use surveys.

Using the Northeast Margaree at Margaree Valley and considering the relationship as developed above, extend the period of record to 50 years at several key locations on each river system. The statistical concept should include cross-correlation with the Northeast Margaree River and with each of the hydrometric stations with similar hydrologic properties. The locations should include the point of diversion, the river outlet and any other such locations as may be defined by the fisheries and land/water use surveys.

F. POTENTIAL USE

Using the baseline data as developed above, evaluate the potential of the project area and the downstream portions of the diverted streams in terms of fisheries, wildlife, tourism, recreation, water supply, forestry, etc.

C. WATER QUALITY

An interpretation of existing "natural" water quality regimes as defined by the basic water quality monitoring program outlined in 5.1D is required. Emphasis should be placed on seasonal fluctuations, the natural cause/effect relationships and correlation with hydrologic/meteorologic conditions. Associations with the fishery and any other identifiable existing or potential resource should be drawn.

6. CRITICAL STUDIES

6.1 General

Some of the findings and conclusions of the MacLaren report, critical to the environmental assessment and ultimate management of the project, were based on a very limited base or on methodology which is open to question by the scientific community, or both. In light of the emergence of a more concrete data base such as the lake monitoring program being carried out by N.S.D.O.E. and the establishment of more concrete or specific guidelines as presented herein, several scientific studies must be carried out. These studies relate primarily to the regimes, which are somewhat interrelated (temperature, dissolved oxygen, pH, nutrient loading, circulation patterns, etc.) and which will be created in the impounded reservoirs. A major study of the effect of flooding the Cheticamp bog complex is presented. In addition, a study of the institution features of the project area is presented with a view towards the formulation of a management plan for the area. The results of these studies will serve as a major input to the environmental impact assessment of the Cheticamp impoundment/diversion component, downstream reaches of the diverted streams and to the ultimate management of the water resources of the area.

6.2 Temperature Regime in Proposed Reservoirs

The optimum summer temperatures for trout and salmon lie between 15°C and 20°C. The optimum winter temperature for developing eggs is 0°C. Ideally, water released from June through October should be between 15°- 20°C. From December through April it should be near 0°C.

It is likely that vertical temperature gradients will exist in the proposed reservoirs. In deep lakes the summer temperatures may range from about 20°C at the surface to 4°C at

the bottom. Winter temperatures may range from 0°C at the surface to 4°C at the bottom.

Studies should be undertaken to determine if there is a basis for concern that downstream temperature regimes will be altered in any biologically critical way. To accomplish this, simulation of the temperature regimes in Wreck Cove, Gisborne, Cheticamp and McMillan Reservoirs should be carried out. Vertical temperature profiles should be predicted for each month. The simulations should take account of the expected operating strategy of the proposed reservoirs and the effects which the outlet levels for maintenance flows and for power generation will have on the temperature profiles. Field data used in these simulations should be collected at the appropriate sites at Wreck Cove.

Simulations of the temperature regime in each of the diverted streams, below the point of diversion, is also required to assess the impact of each impoundment on downstream water use.

Recommendations should be made regarding the outlet levels so as to release water at a temperature appropriate to each season. If necessary, consideration should be given to the provision of several alternate outlets at different levels.

6.3 Dissolved Oxygen Regime

The preliminary assessment carried out by MacLaren Atlantic Limited indicates that severe depletion of dissolved oxygen may occur in the proposed reservoirs. If this is the case, the streams will be deficient in oxygen for some distance below each dam.

Studies should be undertaken to provide a more accurate quantitative prediction of the extent of oxygen depletion

likely to occur in the impoundments, and to what extent this situation is likely to change with impoundment ageing; taking into account the expected operating strategy for power generation, and discharge of water (possibly from more than one depth) for stream maintenance flows.

Environmental parameters used in the predictive model should be measured in situ wherever practicable and otherwise under laboratory conditions using field samples from the site.

6.4 Suspended Sediment Regime in Reservoirs

Materials in suspension are not very harmful to fish at concentrations normally found in nature. However, deposition of the suspended load on a streambed may be very harmful to fish, fish eggs and to invertebrates on which they feed.

The new shorelines of reservoirs will be eroded between the high and low water levels. Some of the eroded soil will be suspended in the reservoir column and released downstream.

Studies should be undertaken to predict if possible the amount of suspended material in the water released downstream and where it will eventually be deposited.

The studies should consider the hydrologic regime of each reservoir as well as estimates of wave energies, erosive effects of ice and groundwater flows. Effects of shoreline slopes, vegetation and of soil characteristics should be estimated. Soil samples should be collected from the future reservoir shorelines and particle size and settling rate determined.

6.5 Effect of Flooding Cheticamp Bog Complex

The Cheticamp reservoir is unique in that a raised sphagnum

bog would be flooded. The decay of submerged terrestrial and bog vegetation of this type under anaerobic conditions, as may prevail in the Cheticamp Reservoir, may produce toxic substances quite harmful to the fishery and other water uses.

A water sampling and analysis program is required for Cheticamp Lake and at several points on the Cheticamp River downstream from the lake to the first major tributary (see section 5.1D, 5.2G). A concurrent laboratory study is required to follow the effects of peat decomposition of water quality.

The objectives of the study are to evaluate quantitatively the anticipated water quality problem and to ascertain the potential for natural reaeration, pH buffering and dilution; and to make recommendations with regard to water treatment facilities that may have to be installed to bring the reservoir water quality up to a standard suitable for release as maintenance flow.

6.6 Institutional Study

As a prerequisite to effective resource management, it is essential that a framework management plan be developed jointly by those agencies/private companies/individuals, etc. that are affected by the plan. The objectives of this study are to identify who is involved in the area, what is their sphere of involvement, what are their short and long term plans, what are their policies respecting the management of their single resource and more important, what are their policies affecting multiple resource management.

An example of some of the agencies and their involvement in this area is as follows:

AGENCY/COMPANY	PRIMARY SPHERE OF INVOLVEMENT
Parks Canada	National Park/Recreation/ Tourism
Environment Canada	Fisheries Management/ Hydrometric and Meteor-ologic and Water Quality Monitoring
N.S. Lands and Forests	Wildlife/Forestry Manageme Fire Control
N.S. Environment	Environmental Management and Protection
N.S. Power Corporation	Proposed Hydroelectric Plant/Water Management
N.S. Forest Industries	Forestry Operations

Undoubtedly there are many more agencies/companies and private individuals involved which require identification and clarification as to their relationships in terms of use of the area.

7. ENVIRONMENTAL IMPACT ASSESSMENT

7.1 General

As indicated in Section 3, the principle areas of concern expressed by the various environmental agencies have been categorized into three modules requiring detailed assessment. These are; (1) downstream effects, (2) the Cheticamp River Basin and (3) other Environmental concerns.

The framework for environmental assessment consists of; (1) the evaluation of the environmental effects of the basic proposal; (2) the formulation of alternatives in light of adverse effects; (3) the evaluation of the environmental effects of the project under each alternative and finally (4) the evaluation of the acceptability of the project in terms of environmental/economic costs under the best alternative.

The approach to the determination of environmental impact is a hierarchial one, that is, the physical effects are determined, then translated in ecological effects and, based on both, the social/economic impact is assessed.

7.2 Downstream Effects

A principle area of concern which has received limited attention in the MacLaren report and others relates to the effect of the proposed project on the downstream reaches of the diverted rivers. Studies should be initiated to assess the natural resources of the downstream reaches of each of the diverted streams and to evaluate the environmental impacts of changes in the hydrologic and water quality regimes resulting from the proposed project. The "natural" resources referred to above includes fisheries, wildlife, recreation, water supply and any other such uses that the water resources are or may be put to. This assessment will include an evaluation of

alternative riparian flow releases and will consider the water quality of such releases. Various environmental designs including but not limited to multiple dam outlets and siltation or settling basins will be considered. Another major consideration will be the impact of alterations in the hydrologic/geomorphological regime on the stream bed characteristics such as potential loss of gravel spawning beds for fisheries.

7.2.1 Physical Effects

A HYDROLOGIC REGIME

Based on the hydrologic models as developed in 5.2E and the proposed riparian flow to be released from the reservoir determine the streamflow regime at each key point as identified by fisheries and land/water use surveys on each affected river system. A comparison, using graphical and statistical technique between existing natural and proposed regimes is to be drawn. Considerable attention is to be afforded to seasonal conditions. Consideration should be given to short term (reservoir filling) and long term effects. Analysis over the 50 year simulated period is required.

B FISH HABITAT

The changes in the hydrologic regime, as determined in 7.2.1A above, must be related to various hydraulic properties; wetted perimeter, mean and maximum depth and average velocity at each section and compared to both the natural regime and acceptable values of each property for the maintenance of fish habitat conditions. The extent of all losses in fish habitat should be identified, quantified and discussed.

C WATER QUALITY

Using the results of 7.2.1A above, water quality conditions of the riparian flow release as defined by the

specialized scientific studies, the physical characteristics of the river are defined by physical habitat and stream hydraulic studies (5.1B), the climatic regime of the area and the existing water quality regimes, determine the post-project water quality regime as reflected by temperature, dissolved oxygen, pH, total dissolved and suspended solids and any other such parameter that may be identified as being critical or limiting to all forms of water use. For example, assessment of the environmental effect on the estuaries of each of the affected rivers will involve a detailed evaluation of alterations in the salinity regimes. Comparisons with the existing regime and optimal and threshold conditions vis a vis fish habitat requirements is required. Where other existing and potential resource uses have been identified in the various surveys, the effect on such uses vis a vis changes in water quality conditions thorough evaluation of specific water requirements will be required.

D SEDIMENT REGIME

During construction, significant alterations to the sediment regime of the downstream portions of the diverted streams may be introduced. Elements of the project notably dam and access road construction that will disturb surficial materials will be overlain on physical terrian maps and other information generated in 5.1A and assessed in light of planned erosion/ sediment control facilities encompassed in the design concept. This will include consideration of construction timing and climatological data. For example, exposed soil during the late spring or early summer months will be subject to adverse climatological conditions and would present a greater hazard in terms of sediment influx. Likely deposition patterns should be determined, in terms of timing and extent and assessed. This will

include a detailed discussion of estuarine sediment balance [illegible] highlight major areas of conflict, e.g. where spawning beds may be affected. Baseline conditions will be derived from the recommended physical habitat and stream hydraulic studies (5.III) and the oceanographic study of estuarial sediment distribution.

In addition to the above, the long term effect on the sediment regime must be assessed. The degree, including quantity and type, to which the input of sediments will be decreased, should be determined. The effect of this aspect should then be assessed in terms of long term alterations in each river system including the estuaries. The extent to which changes in the hydrologic regime will effect erosion or lack of it and sediment transport requires assessment. Conflicts with fishery and other resources must be determined and documented.

7.2.2 Ecological Effects (Aquatic Biology)

The evaluation of the effects of the project, both long and short term, on the aquatic biology of the downstream portions of the diverted streams must address itself to the following considerations:

i. alteration in productivity and water quality in general
ii. alteration in fish habitat and spawning beds
iii. alteration in flow regime which, besides affecting (i) and (ii) above, may eliminate spawning and habitat grounds or at least make them inaccessible
iv. changes in the sediment transport regime may have both long and short term effects.
v. the estuaries which are very sensitive to changes in salinity and temperature may be adversely affected
vi. the sediment and flow regimes balance in the estuary at the mouth may be affected and

vii. other existing and potential water uses may be affected by changes in water quality.

viii. the emergence of "nuisance" aquatic plants and organisms from the disruption of the above balances may affect fisheries and other water uses.

7.2.3 Social/Economic Effects

Based on an appraisal of 7.2.1 and 7.2.2 above and considering inventory data collected regarding resource base and resource use, evaluate the physical and economic effects in relation to:

i. Fishery - loss of resource and loss of opportunity in relation to future management options. The "cost" may be determined based on providing fish via a fish hatchery operation or through other intensive management techniques, etc.

ii. Recreation - loss in terms of sports fishery, boating/canoeing, aesthetics, facility relocation, etc.

iii. Other resource uses - the loss to other existing or potential (opportunity) resource bases and uses must be evaluated.

iv. The long term effects on adjacent communities with emphasis on long term development plans.

7.2.4 Development of Alternatives

Should adverse environmental effects result from the basic proposals which are unacceptable to the environmental agencies, the next logical step would be to develop alternatives which alleviate those effects in whole or in part. While not an exhaustive list, the following alternatives at least cover the scope of those that may be considered.

i. increase riparian flows

ii. multiple outlet works for riparian flow releases

iii. erosion control measures including construction methods timing and remedial measures such as settling basins.

iv. water treatment facilities (flocculation, pH buffering, etc.)

v. alternative reservoirs reserved for riparian flows

vi. remedial measures such as fish weirs, channel excavation

vii. intensive management schemes

7.2.5 Environmental Impact Assessment of Alternatives

For each major alternative or any combination thereof, the environmental effects will be assessed using the foregoing (7.2.1 - 7.2.3) as a framework. A relative evaluation of alternatives aimed at mitigating similar environmental effects is required.

7.2.6 Evaluation of Economic/Environmental Costs

The basic premise employed throughout these guidelines is that any decisions that affect more than one resource base or use must reflect or be based on a comprehensive evaluation of all economic/environmental costs involved. It is hoped that any major decision respecting the proposed power development or components thereof be based on a framework of multiple resource management. It must be recognized that it is not possible in all cases to establish a dollar figure on a natural resource such as fisheries. However, it is possible to make a comparison in subjective terms.

Each major alternative or combination thereof must be evaluated from the perspective of additional cost or loss of capacity/energy to the project. This will establish the cost to the project in dollars. Painted against this background, the relative "environmental" benefits/losses, whether they be tangible or intangible, must be formulated. When evaluating environmental benefits/losses, it is suggested that consideration be given to opportunity losses but that the basis for comparison be existing conditions.

7.3 Cheticamp River Basin

One of the key conclusions of the MacLaren report identified the Cheticamp Basin as the most environmentally sensitive areas of the project. The Cheticamp bog complex supports a vegetational mosaic which is unique to the Maritime Provinces. The Cheticamp area provides most of the habitat in the project area for the ungulate population. The fishery resources, notably Atlantic Salmon, of the Cheticamp River supplies excellent early run salmon angling under almost pristine conditions. The Cheticamp estuary is controlled by a sand bar at its mouth which may be quite sensitive to changes in the hydrologic regime. The Cheticamp estuary may be altered by changes in the hydrologic regime through changes in the salinity and temperature regimes. There is considerable uncertainty concerning the effect on water quality of flooding a raised sphagnum bog.

Based on a thorough evaluation of existing data sources such as the MacLaren and S.N.C. reports and a field reconnaissance of the area, a formal environmental impact assessment of this component must be carried out as soon as possible. This will include a complete and integrated environmental, engineering and economic evaluation of all alternatives ranging from (a) no Cheticamp impoundment or diversion, (b) Cheticamp diversion only, (c) Cheticamp diversion with small impoundment (i.e. present lake only), (d) various levels of storage development with diversion, to (e) the maximum scale of development as proposed.

7.3.1 Physical Effects

A Land

The immediate effects of the project on land are obvious. The exploitation of borrow sites and the levelling of the landscape for roads scar the landscape. The potential

of eliminating unique land types is introduced and

B Vegetation

Coupled to disruption of land is the disruption of vegetation communities common to the land type. In most instances this will increase the edge effect occurrence; this should be quantified and assessed. The potential of eliminating a vegetation type unique to the area and the Maritimes should be assessed.

C Wildlife

The construction of steep sided canals and heavily travelled roads may create impediments to migratory movement of wildlife in the area. The possibility of this arising should be assessed. The effect of the obliteration of habitat on the wildlife of the area requires assessment.

D Erosion/Siltation

The creating of new shorelines by impoundment of the Cheticamp River entail the possibility of a high level of erosion until stability sets in. Such an occurrence may result in siltation of the reservoir and subsequently downstream. An assessment of such a possibility is required.

E Forestry

The impact of the project's access roads on forestry to the Cheticamp Basin is minimal if any at all. The potential of the access road as a means of attaining the area of the headwaters of the Margaree River and the relationship of this to the forestry industry should be assessed. An assessment of the project's effects on forestry should also be carried out.

7.3.2 Ecological Effects

The effects of the project by altering the physiography of the area, results in a redistribution of stresses in the ecological balance by introducing new component systems to the area. The time it takes for the system to attain balance varies with trophic level and intensity of alteration. The following should be considered in assessing the project's impact on the ecology of the area.

A. Terrestrial Ecosystem

The alteration of drainage patterns by roads, reservoirs and canals will result in vegetation changes both gradual and rapid. This change should be assessed, also, the effect on change in habitats needs assessment.
The introduction of man as a more frequent visitor to the area should be assessed.

B. Aquatic Ecosystems

With impoundment, water quality can be expected to change, sedimentation will increase and the littoral plant community as it presently exists will be eliminated. These effects and others resulting from impoundment and the subsequent operation schedule should be assessed in terms of nature of the system to be established.

7.3.3 Social/Economic Effects

Based on 7.3.1 and 7.3.2 above evaluate the effect of the project on recreation and other resource uses in a similar manner to 7.2.3.

7.3.4 Development of Alternatives

Should adverse environmental effects result from the basic proposal which are unacceptable to the environmental agencies, the next logical step in the process is to develop alternatives which alleviate those effects in whole or in part. Without

knowing the level and intensity of the adverse environmental effects, it is impossible to outline definitive alternatives at this stage. However, the following list of alternatives is presented from the point of view of establishing the scope to be considered. These are in addition to those presented in section 7.2.4.

i. Cheticamp diversion only - no impoundment.
ii. Cheticamp diversion with small impoundment (present lake)
iii. Various levels of storage development ranging from (ii) above to the proposed scale of development.
iv. Intensive wildlife/fisheries management strategies.
v. Alternative sites for access roads/borrow areas.
vi. Alternative sites for spoil disposal.

7.3.5 Environmental Impact Assessment of Alternatives

For each major alternative or any combination thereof, the environmental effects will be assessed using the Section 7.2.5 as a framework. A relative evaluation of alternatives aimed at mitigating similar environmental effects is required.

7.3.6 Evaluation of Economic/Environmental Costs

The basic premise employed throughout these guidelines is that any decisions that affect more than one resource base or use must reflect or be based on a comprehensive evaluation of all economic/environmental costs involved. It is hoped that any major decision respecting the proposed power development or components thereof be based on a framework of multiple resource management. It must be recognized that it is not possible in all cases to establish a dollar figure on a natural resource such as fisheries. However, it is possible to compare the cost/benefits in subjective terms.

Each major alternative or combination thereof must be evaluated from the perspective of additional cost or loss of capacity/energy to the project. This will establish the cost to the project in dollars. Painted against this background, the

relative "environmental" benefits/losses, whether they be tangible or intangible, must be formulated. When evaluating environmental benefits/losses, it is suggested that consideration be given to opportunity losses but that the basis for comparison be existing conditions.

7.4 Other Environmental Concerns

Previous sections of this report have dealt with guidelines for impact assessments of major components of the proposed project. This section considers the parts of the project that are not included above but have generated concerns from the committee. For instance, the location of and specifics of the camp to be built on the plateau need to be assessed. Similarly transmission line routing, tunnel excavated material, dump sites, road routing, borrow material and location are other site specifics which need assessment. To properly assess the site specifics identified below some of the data will be required to be collected in map format. Furthermore, in planning and formulating a management strategy (see section 8) a total inventory of the area is required. Therefore to fulfill both a total mapping of the area is required as identified below.

7.4.1 Physical Effects

For each project elements identified in section 2 identify acreages, volumes and types of land and vegetation altered, moved or destroyed both directly and indirectly.

7.4.2 Ecological Effects

Based on 7.4.1 above identify the repercussion of each on the existing balance and assess the effect on the balance of the ecological systems common to the area.

7.4.3 Socio/Economic Effects

Based on 7.4.1 and 7.4.2 above evaluate the effect of the project on forestry and the concerns as outlined under 7.2.5.

7.4.4 Alternatives

Should adverse environmental effects be established from the impact assessment carried out above, alternatives must be considered.

For example:

- incompatible road routing and terrain sensitivity must be made compatible by suggesting alternate road routing.
- similarly for transmission line routing, borrow areas, dump sites, etc.

7.4.5 Assessment of Alternatives

For each major alternative or any combination thereof, the environmental effects will be assessed using the foregoing as a framework (section 7.2.5). A relative evaluation of alternatives aimed at mitigating similar environmental effects is required.

7.4.6 Evaluation of Economic/Environmental Costs

The basic premise employed throughout these guidelines is that any decisions that affect more than one resource base or use must reflect or be based on a comprehensive evaluation of all economic/environmental costs involved. It is hoped that any major decision respecting the proposed power developmer or components thereof be based on a framework of multiple resource management. It must be recognized that it is not possible in all cases to establish a dollar figure on a natural resource such as fisheries. However, it is possible to compare the costs/benefits in subjective terms.

Each major alternative or modification thereof must be evaluated from the perspective of additional cost or loss of capacity/energy to the project. This will establish the cost to the project in dollars. Painted against this background, the relative "environmental" benefits/losses, whether they be tangible or intangible, must be formulated. When evaluating environmental benefits/losses, it is suggested that consideration be given to opportunity losses but that the basis for comparison be existing conditions.

8. MANAGEMENT STRATEGY FORMULATION

8.1 General

Based on the results of the Environmental Impact Assessment and constraints identified therein a management plan is to be formulated to:

1. recommend the most appropriate method of operation of the project to ensure continued maximum protection of the natural resources of the area.
2. identify requirements for monitoring the effects of changes to the natural resource base in the area as a whole, and
3. make alternative proposals covering the general management of the total area.

8.2 Considerations for Management Strategy Formulation

8.2.1 General

Effective management of the water and natural resources of the area after the project is in place and in operation will mitigate some of the adverse effects of the project. In some cases, the infrastructure requirements for effective management will have to be integrated into the design of the project. The following is a partial listing of some of the considerations which should be taken into account.

1. The project and its associated infrastructure will open up a vast area, if so desired, to the general public conducive to a variety of recreational activities including fishing, hunting, camping, nature viewing, etc. The provision of the area or parts of it to the general public as a recreation area requires the following considerations:
   a. An examination of N.S.F.I. policy re access roads and the compatible formulation of a joint policy governing access to all roads including those of the N.S.P.C. is required. This has a number of implications, the most

notable of which is the requirement to provide an accessible road and to maintain it to similar standards of a secondary highway.

b. If an "open door" policy is adopted for an area, the environmental effects, especially aesthetic, will become more severe if an accessible reservoir is subject to excessive fluctuations. The establishment of a near shore and littoral plant community would also be an important requirement.

c. An "open door" policy will be enhanced if management options such as fish stocking, tree marking, provision of recreation facilities, warden patrols, etc., are provided.

d. The aesthetics of the area as referred to in "b" above should be considered in project design, construction and post construction activities. The location of spoil sites, selection and reclamation of borrow pits, access road routing/design/maintenance, landscaping of scared surfaces such as around each accessible dam site, provision of buffer zones along roads etc.

2. Incompatible resource use objectives such as the concept of a wilderness area, a policy of Parks Canada, and the "open door" policy of N.S.F.I., require rationalization.

3. The multiplicity of use has to be resolved as to whether uses overlap or abut over the area. Zoning for uses may be required.

4. The management of the water resources of the downstream reaches of the diverted streams require that maintenance flows, as determined in the Environmental Impact Assessment, be intensively managed.

8.2.2 Environmental Monitoring

The management of a resource requires an up-to-date knowledge of the state of the entity being managed. This is normally

accomplished through a network of stations at which various indicator parameters are monitored on a regular basis. A comprehensive network of environmental monitoring sites encompassing the factors listed below must be designed and established. The design must be based on the management strategies adopted.

A. HYDROMETRIC NETWORK

A comprehensive network of streamflow monitoring stations will be required to monitor riparian flows and conditions downstream. This would require at least two stations on each river system, one located immediately below the point of diversion and one at some key location further downstream as determined by the environmental assessment of downstream effects.

B. CLIMATOLOGICAL NETWORK

While it is presumed that the N.S.P.C. would install a network of meteorological stations for the purpose of water management, other facets of environmental management may require similar information. For example, it may be desirable to supplement existing stations in the area to establish a comprehensive fire hazard index system. In addition, estimates of precipitation, snow pack, evaporation temperature combined with streamflow data may provide a basis for the future optimization of riparian flow releases.

C. WATER QUALITY

As a basis for management of riparian flow releases, a comprehensive network of lake and stream monitoring stations is required. Initially, the network should include provision for complete water chemistry, nutrients, D.O., temperature, pH, T.D.S., T.S.S. However, as the regime is established, the parameters may be confined to indicator parameters. Should a multiple dam outlet concept be employed, vertical estimates of each parameter will be required in each of the reservoirs.

SUMMARY OF REQUIREMENTS

For an adequate environment impact assessment to be made the following requirements have to be met.

1. Detailed description of all elements of the Project. (Sect. 2)
   a. Dams
   b. Corals
   c. Impoundment Areas
   d. Access Roads
   e. Transmission Lines
   f. Tunnels
   g. Control and Reception Building
   h. Camp Sites

2. Detailed description of the Environmental Base. (Sect. 3)
   a. Physical Terrain
   b. Plant Communities
   c. Climate
   d. Water Quality
   e. Land/Water Use
   f. Near Shore Resources and Activities
   g. Fish Populations
   h. Hydrology

3. Ecological Description of the Area. (Sect. 5)
   a. Fauna Habitat
   b. Trafficability
   c. Potential Borrow Areas
   d. Erodibility of Terrain
   e. Hydrologic Analysis
   f. Potential Use
   g. Water Quality

4. Critical Studies (Sect. 6)
   a. Temperature Regimes in Proposed Reservoirs
   b. Dissolved Oxygen Regimes

D. FISHERY RESOURCES

A regular monitoring program should be initiated to establish management program for the fishery resources of the area. This will include the monitoring of the created reservoirs, tributaries thereto, and each of the affected rivers downstream of the point of diversion. The basic components of the program should include fish population by species, size and location as well as changing habitat and spawning beds.